Shellfish Propagation
2005

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December 2005

Propagation:

Shellfish propagation for the Town of Nantucket, for the year 2005 consisted of mainly quahogs, oysters, and scallops. Muscongas Bay Aquaculture, of Maine was able to provide one million oysters, and one million quahogs at the 1mm range. Transects and quadrates of soft shell clams were performed to test the success of earlier plantings. Grow out of the shellfish took place at the Boat House at Brant Point, while collection of scallop spat took place in the harbor. Spawning cages were also used to increase the natural set of scallops, and this year a total of 12 cages were employed. A grant from the State also allowed for the reconstruction of the pier at the Boat House, and though beneficial in the long run there was no room for the use of a second flupsy this summer.

Oysters:

Oyster grow out of one million animals at 1mm was successful with little mortality. Oysters arrived in early June 6/16, and were grown out into November. However due to the limited space available these oysters did not reach their maximum growth potential. The average size range was 16-22mm upon release 10/19 -11/9. Approximately 25,000 sieved early attained a greater size range 30-35mm. This larger group was released at a specific location (Old North Wharf) early to make room in the flupsy. Also released with this group were approximately 100 individuals that had been over wintered a third year. This allowed for smaller younger males and larger older females to be set in the same location.

The majority of oysters that were grown out in the floating upweller at the Boat House were released in October. However pearl nets were used at the Boat House to over winter 2,000 animals, and aquaculture trays were employed in Madaket to over winter 9,000. These over wintered oysters will be used to set both male and female oysters at the same time, so that when temperatures rise, both sets of gametes will be released. This should increase the potential for fertilization, initiating a natural setting process. Hopefully this would then begin to build a reproductive population large enough to have an effect on improving water quality through bio filtration.

Naturally occurring sets of oysters are now being seen in Sesachacha Pond, as well as Madaket Harbor (Personal observations, and conversations with Madaket Harbormaster). So the oyster propagation efforts appear to be working, however until independent reefs are established recruitment will have to come via aquaculture to ensure the viability of a self sustaining reef. The potential for bio filtration is great because each adult oyster can pump up to 50 gallons of water a day. Also, if reefs can be established in closed areas now, then they will be able to set remote satellite areas on their own. Acting as spawning sanctuaries, these reefs will be able to propagate oysters in “open to shell fishing” areas where they can then be harvested.

Oysters are released prior to the winterization of the Boat House as well as prior to the falling water temperatures that would initiate the period of cessation.

Number and location of oysters released in October and November:

1. 300,000 Sesachacha Oyster Reef
2. 225,000 Old North Whraf
3. 410,000 Madaket
4. 5,000 Brant Point
5. 2,000 Boat House Pearl Nets

Quahogs:

Quahogs were again acquired in a large number this year, (1,000,000), because of this, a smaller size was ordered, (1.0mm). Greater quantities of shellfish can be purchased at smaller size ranges, then gown out to a larger size to avoid predation. The grow out process should continue for as long as possible. This will maximize growth throughout the summer. A release of the shellfish when temperatures fall, (approximately 45º F), before winter will also increase survival. This is when many marine species, including predators go into a dormancy, or (cessation). This less expensive strategy toward propagation may overwhelm the predators, and result in a more efficient way to maintain a shellfish population that is actively fished. This shipment of quahogs also arrived in mid June, on 6/15, and was placed in the flupsy for grow out. They were released on 10/26, and ranged in size from 3 to12mm. Smaller size ranges this year were a result of cramped grow out conditions due to construction at the Boat House. Mortality was higher this year as a result, estimated 5-10%, and some empty shell was seen during their removal, and release.

Number and location of quahogs released in October:

1. 450,000 Horse Shed
2. 450,000 Monomoy
3. 25,000 Brant Point

Soft-Shell Clams:

Soft-shell clams were not ordered this year as the propagation efforts from ’02 and ’03 appear to have taken off well. Transects and quadrants, as well as conversations with shellfish harvesters show a healthy abundant supply on most flats. An average of 5 soft shell clams were found per meter squared outside Polpis Harbor. Higher numbers were found in other areas around the harbor. The lower harbor appears to be acting well as a spawning sanctuary, as it is closed to shell fishing because of fecal coli form counts, and Division of Marine Fisheries standards. The planting of soft shell clam seed also appears to be working well as sites are carefully selected. If sites show a lack of clams, but an abundance of worms they are left fallow for at least two years. This is to allow the predator to prey ratio to balance out before plantings. If site selection were ignored, then

plantings may only be feeding the worms, and crabs in that area. A natural cycle of crop rotation may be enhanced by propagation for harvesting if area selection is monitored closely. Transects and quadrants must continue to be performed if a healthy population, (one that can be fished steadily, and has the ability to replenish itself) is to be maintained. Orders of more soft shell clams for grow out will be dependant upon these findings, as well as information from the recreational harvesters.

Scallop Spat Collection:

Spat collection for '05 was much better than the '04 season. Spat bags on 4 lines, with 25 bags each for a total of 100 bags were set mid June 6/14-6/17. The lines were placed in 3rd Bend, 4th Bend, off Pocomo West, and Quaise. An additional line with 6 bags was also set at the Boat House at this time. The placement of the lines in the various areas was chosen to check for the possible recruitment from the left over, and relocated 2nd yr. Classic adults from 4th bend after the '04 -'05 fishing season. A Fall line, also with 25 bags was set August 16th off Pocomo West. Traditionally there are two spawning sets in Nantucket Harbor. The first occurs in the late spring / early summer when temperatures rise rapidly from 68ºF to 72ºF, and the second when temperatures fall back through that range (Belding, 1910). However any temperature fluctuations through that range either up or down may induce additional spawnings. Spat collected was released in Coskata Pond, in 3rd Bend, and over Hussey Shoal.

Multiple spawning events undoubtedly occurred this summer because of several factors. Temperatures first moved through this range between 6/24 (68ºF) and 6/27 (74ºF), (temperatures taken at Brant Point unless otherwise stated). Temperatures then fluctuated for the next several weeks until 7/15 when it rose markedly from 72ºF to 78ºF by 7/18. The recorded temperature did not rise above 78ºF, which is good for the health and metabolism of the bay scallop. The average temperature for the rest of July and August was approximately 76ºF. However the temperature did not drop through the inducible range until 9/22 to 9/29 when the recorded temperature went from 72ºF to 68ºF. Slight variations may have occurred throughout the harbor, especially where shallow areas with little circulation are affected by sunlight and rainfall.

Sexual maturity of the bay scallop also plays a major role as to when spawning events may occur. Scallops over the age of 12 months with well developed gonads, and sizeable body mass will spawn with the as mentioned temperature fluctuation. However there may be as many as 6 age classes of scallops in the waters of Nantucket following the Fall set of any given year. An age class represents scallops spawned at different times, usually summer and fall overlapping a period of three years. The reproductive stock at the age of spawning of this biomass would include 1st yr. Classic adults (12-14 months, with a growth ring between 1 1/5" (30mm) to 2 3/5" (65mm)), potentially Nubs (12-14 months, provided that they have an annual ring > 1/5" (10mm)) (Belding,1910). Also capable of spawning are scallops that have two growth rings, Nub adults (18-20 months), and 2nd yr. Classic adults (22-24months). The early spawning scallops that would create Classic adults (scallops with growth rings high on their shell) are the 1st and 2nd yr. Classic adults, and the Nub adults. Nubs will spawn late, if at all, depending on size of growth ring and time of falling temperatures. This results in the creation of more Nubs. Variations on this model may occur, dependant on the health of the previous

groups, and fluctuating temperatures. This then may result in the creation of more Nubs, or scallops with growth rings lower on their shells.

The majority of the early spawning biomass for '05 was made up of 2nd yr Classic adult scallops that had not been harvested because they were relatively unmarketable because of their small size. Most other age classes capable of spawning had been removed from the biomass as a result of over fishing, and the resultant effect of decreased spawning potential. This was the result of allowing the fishermen to harvest Nubs over the last two and a half fishing seasons, eventually eliminating the spawning stock that sets early. Usually scallops are harvested before they reach into their third year of life, (dependant on fishing pressure). This year Nantucket was very fortunate to have a substantial potion of this age group left behind. Approximately 3,000 bushels of these scallops remained in 4th Bend after the '04 / '05 fishing season. Roughly 1,000 bushels of these scallops were moved by the fishermen under the supervision of the Marine Dept. to multiple locations through out the harbor. The reasoning behind this was to create multiple spawning locations that could function independently and not be adversely affected by a major die off due to their age and health. Groups of these scallops were caged to monitor maturity and mortality; these results will be discussed later.

By July 19th spat was beginning to show in the bags at sizes between 4-9mm. The lines were checked weekly after this point to monitor growth rates. One bag from a different line was examined each week. This monitoring revealed that an early set had occurred, and though seed were not found in prodigious amounts it did prove that the 2nd yr. Classic adults had successfully reproduced. Results from the spat bags laid by the Maria Mitchell Association also showed an early set had occurred (Kennedy, 2005). Their bags were set later, and at intervals; and though smaller in sampling size this did prove to reveal some useful information. As hypothesized, multiple spawning events were occurring throughout the summer. Some of the later events showed greater fecundity than the first set, and may have been the result of delayed spawning from the 2nd yr. Classic adults. Due to their age, and approaching the end of their life cycle a substantial portion of these scallops that had been left in 4th Bend may have spawned a little late. Also they may have been shocked by the move at the end of the fishing season, which could also have resulted in a delay in the spawning process. Nevertheless these spawning events must have come from this population as transect and quadrants showed there were no other age classes in great enough magnitude to produce these early sets of spat.

The fall line set by the Marine Dept. on Aug 16th caught the greatest quantity of spat for the summer of '05, but was actually set too early. A final "fall set" spawning temperature (68ºF) was not reached until September 29th a full month later; which means that another mid summer set had occurred. On 10/5 one of the bags from the fall line was checked and contained spat up to 10mm; based on growth rates these scallops were most likely set shortly after the fall line was laid out. Also one month of bio fowling in water temperatures above 72ºF would have prevented the setting of a later spawning event. These late falling temperatures may have allowed some of the Nubs to spawn, but with gonad masses roughly 1/3 the size of mature adults at that time, this potential set from the Nub age class would have been limited. A positive side affect of spawning late is that with falling temperatures predation is also limited. So the "fall set" collected by the

Marine Dept. would most likely have come from smaller ringed 1st yr. Classic adults, and 2nd yr. Classic adults that spawned late as the result of some stress.

Total Spat Collected

"Summer Set": 100 Bags: Average 10 per bag, 1,000 Total.

"Fall Set": 25 Bags: Average 650 per bag, 16,250 Total.

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Scallop Seed Relocation:

The Marine Dept. has often worked in the past with fishermen to move large amounts of scallop seed at the end of the fishing season. The purpose of this endeavor is to improve environmental conditions for the seed, so that spawning and development are optimal. The decision to do so is often based on location, and depth in the harbor, as well as the concentration or number of seed in any given area. The need for relocation is not always necessary. However if there are high concentrations in shallow areas, especially in the lower harbor, the intended areas must be investigated with relocation in mind. Optimal relocation sites would be in mid harbor areas, where there is a depth of 8-10', and eel grass is present in concentrations of 25% or greater. This takes into consideration for spawning purposes, circulation with respect to larval retention time, and environmental conditions such as water temperature and dissolved oxygen content. Multiple spawning sites may then be created allowing for a division of the setting process; which will then not subject a significant portion of the reproductive biomass to any one adverse environmental or climatological affect.

The situation after the '04 / '05 fishing season was very different. A densely packed population of small 1st yr. Classic adults had been left over in 4th Bend, as previously mentioned. Reports of this situation had come from fishermen Doug Smith, who later helped investigate, and then coordinate a large scale relocation. Over a dozen boats with twice as many fishermen moved approximately 1,000 bushels in one day to a variety of locations inside Nantucket Harbor. This stock of scallops was checked regularly throughout the summer of '05. Several of the over winter spawning cages had been filled with these scallops to monitor maturity, and mortality; which will be discussed later. Diving methods were used to collect and inspect the health and spawning status of the scallops that had been left in 4th Bend. An estimated 2,000 bushels of the 2nd yr. Classic adults remained in this area, and were checked when time allowed. A dive on 7/14 confirmed that these scallops were ripe and spawning as evident by the coloration of their gonads. Quadrants and transects showed that approximately 80% had survived past the time of the first temperature induced spawning event. However by the end of the summer, 10/7 the mortality had increased dramatically. Six 1 meter squared quadrants showed mortalities close to 100%. The range was from 88% to 100%, and the total sum of the percentages was 96% mortality from this sampling round. These quadrants included all shell in the sample area, some of which may have been a year old; so this was not a survey of recent mortality.

Dives throughout the summer showed the majority of this 4th Bend stock to be in good condition, and spawning well. This situation has never been documented before, and in fact the general consensus is that bay scallops do not live into their third year, and

do not spawn more than once in their life time. The level of effort that goes into fishing usually eliminates the older age classes, and this has proven to be a unique circumstance.

Scallops basically live to reproduce, and spawning is an exhaustive process which usually results in some level of mortality in any mature age class. The number and close proximity of individuals in this area would have created a stress on water quality, decreasing dissolved oxygen and increasing the death rate. So it was well advised to thin out this area, and create multiple spawning locations. Nearing the end of their life cycle mortality was expected to be high, but in no way were these scallops wasted. The recruitment from this population has been a substantial factor in sustaining Nantucket's scallop fishery.

Scallop Spawning Cages:

Spawning cages were maintained and monitored from last year to this year to supplement the natural spawning biomass of bay scallops in Nantucket Harbor. Scallops are known to spawn in mass, and so the density of scallops in close proximity should increase the potential for fertilization. Stocking densities have varied slightly from year to year. An optimal number for survival through the spawning season was determined following the summer of '03. The mortality rates were very similar between the densities of 30 -50 scallops per tray, so the number was increased to 50 individuals per tray. An additional large plastic cage with eight trays was added to last years effort. This cage was loaded with 175 soon to be 2nd yr. Classic adults from 4th Bend following the '04/'05 season, and placed at the Boat House.

The cages #s 1-12 were set up between 5/04, and 9/04 to be over-wintered because of the lack of seed expected to be recruited, and subsequently recruited in the summer of '04. This is because of the likelihood that most of the nubs from '02 would be fished out during the '03 / '04 season. This would result in a lack of large seed recruited into the summer '04 set. The fishing out of nubs from '03 would also greatly diminish the potential productivity for the summer spawning event of '05. The trend towards fishing on Nubs also decreases the population size of large ringed Classic adults. The combination of the loss of these age classes greatly reduces the spawning potential for any given summer. Based on the lack of recruitment in '04 the decision was made to set up spawning cages for '05 in '04. By loading the over-wintered spawning cages with 1st yr. Classic adults we were creating spawning sanctuaries with soon to be 2nd yr. Classic adults that should spawn at the first temperature spike through 70° F, provided that they survive. As a side note this may also prove to be a good test of mortality on the 2nd yr. Classic adults, of which only 20% are believed to survive beyond their first fishing season.

Cages were collected at the beginning of the '05 summer, approximately the same time as the initial spawning event according to temperature; (6/21/05-7/11/05). These cages had also been checked at the end of the '04 spawning season. At that time, when these scallops were 1st yr. Classic adults, the dead and slipped hinged animals had been removed. By the summer of '05, these scallops had now been caged for over a year, with the exception of cages #9-12 which were loaded with only 30 per tray, (90 each) on 9/21/04-9/24/04. The mortalities are as follows.

Cage#	Final Spawning Event ’04	First Spawning Event ‘05
1	328 Alive, 18% Mortality	72 Alive, 82% Mortality
2	350 Alive, 12.5% Mortality	60 Alive, 85% Mortality
3	333 Alive, 16.8% Mortality	Missing
4	322 Alive, 19.5% Mortality	112 Alive, 72% Mortality
5	108 Alive, 28% Mortality	0 Alive, 100% Mortality
6	105 Alive, 30% Mortality	3 Alive, 98% Mortality
7	49 Alive, 67% Mortality	4 Alive, 97.5% Mortality
8	50 Alive, 67% Mortality	50 Alive, 67% Mortality
9	90 Alive	11 Alive, 88% Mortality
10	90 Alive	10 Alive, 89% Mortality
11	90Alive	3 Alive, 97% Mortality
12	90 Alive	9 Alive, 90% Mortality

In addition to cages #s1-12, a small cage was kept at the Boat House with 24 scallops, along with a large plastic cage which was loaded with175 scallops on 4/4/05. These scallops were collected during the relocation of stock from 4th Bend. The mortalities do not suggest overall mortality as the collection date was much later than that for cages 1-12; they are as follows.

Boat House	Spring ’05	First Spawning Event ‘05
Small Cage	24 Alive	20 Alive, 17% Mortality
Large Cage	175 Alive	153 Alive, 13% Mortality

Three small cages were reloaded and placed off Pocomo west for the summer to test further for mortality throughout the summer. The first two were loaded with scallops from the large cages #s 1-4, on July 1st. This was to allow us to follow mortality through to the end of the summer. The third cage was loaded with wild 2nd yr. Classic adults from 4th Bend on July 15th. This was to allow for a comparison on mortality between scallops that had been caged for over a year, verses scallops left in the wild. It is speculated that scallops surviving the summer spawning process will survive into the fishing season. These cages were hauled out and checked August 23rd, and on the 24th. The cages were loaded with 105 scallops, 35 per tray, the mortalities are a reflection of summer death rate, and do not project total mortality; they are as follows.

Summer Cage#	July, ’05	August, ‘05
1	105 Alive	10 Alive, 90.5% Mortality
2	105 Alive	12 Alive, 89% Mortality
3	105 Alive	35 Alive, 67% Mortality

As expected mortalities were high with this aging population of scallops, what was not expected was that many survived into their third year to spawn a second time.

The varying degrees of mortalities in the cages can be explained by the health of the individuals placed in the cages, and the duration of time spent in the cages. As learned from previous years of caging scallops, mortalities are increased by decreased circulation and decreased movement. Spawning may also be delayed as a direct result.

A review of the different cage groups helps to explain the increased and varying mortalities. Cages 1-4 were filled with scallops from various areas; these like the others collected were set sometime in the summer of 2003. They were collected in the summer of ’04 after having over wintered one season. Over wintering again in a cage, they would be approaching their 2nd year of adulthood in the summer of ’05. Living into this summer would have them living into their third year of life. This makes them very old for scallops, but also allows them a second opportunity to spawn and add back to the biomass. Their age, the process of spawning, and the adverse environmental conditions of being caged took their toll. This can be seen in the level of mortality on average just below 80%.

The scallops in cages 5-8, had an average mortality that was just above 90%, a noticeable difference. Presumably these scallops had come from a mass stranding of seed at the head of the harbor in ’03. This would have created a greater stress on these animals and resulted in greater mortality. Cages 9-12 were also filled with scallops from this group, but were collected and caged at a later date. The average mortality here was also 91%. This would suggest that the three month lag time in collection over the summer did not affect overall mortality in this population. And as the effort of spawning does increase mortality, this may also suggest that this population did not spawn; at least with any great success in ’04. Spawning was also discussed in the ’04 propagation report, where many of the gonads that were inspected from this population did not show signs of spawning; this was seen in both groups, weather caged early or late.

The Boat House cages reflect an entirely different mortality rate. This is because they were collected at the end of the ’04/’05 fishing season, and checked just prior to spawning. This was done in order get an estimate on what percentage of the population of 2nd yr. Classic adults in 4th Bend (estimated 3,000 bushels) would survive to spawn in the summer of ’05. The average mortality from these two cages was 15%, suggesting that 85% of this population survived to spawn. This along with spat collection also suggests that the coordinated relocation of these scallops from 4th Bend was a successful and valuable effort towards scallop propagation in Nantucket Harbor.

The summer cages off Pocomo showed an ever increasing mortality rate, as expected. The scallops in summer cages 1 and 2 came from the large scallop cages 1-4 over wintered off Pocomo originally. Following this group to virtually the end of its life cycle we see a total mortality at the end of the summer of 98.5%. Summer cage 3 was loaded with 105 scallops collected from transects performed in 4th Bend. Though their time in cage was relatively limited, their mortality was fairly high (67%). This was probably due to their age and stress induced by spawning, and may reflect the death rate of the wild population of 2nd yr. Classic adults from 4th Bend.

The affects of caging may vary dramatically compared to a wild population of the same age class. The lengthy time period of caging for cages #s 1-12 created environmental conditions too exacting for scallops of this older age class. Over wintering of cages is also very difficult, especially if the harbor freezes over, and cages are lost or moved any distance. Spawning cages when used should be loaded with Nubs at the end

of the fishing season. This will allow mature Nub adults, that are still relatively young (18 months), to spawn early at the first temperature set. After approximately one week has passed with temperatures over 72ºF, these cages can be checked for spawning, mortality, and general health of the Nub adult scallops within. At this point in time the scallops should be released, as this will prolong their life expectancy. In the wild these scallops will have far better environmental conditions, and better chances of making it to the fishing season.

The spawning potential of a "scallop cage" has never been measured, but it must greatly contribute to the overall biomass of any given area when deployed. In other New England areas void of scallops where water quality is still good, attempts are being made to re-established scallop populations using these cages. Spawning cages will continue to be used in the future in order to enhance the fecundity of the natural population. However the over wintering process for these cages will be discontinued, as it is detrimental to the health of the animals. The locations for deployment will be based on water quality, habitat viability, and circulation.

References

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